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United States Patent Application

Title: PREMIXED FUEL BURNER ASSEMBLY

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This application claims the benefit under 35 U.S.C. 119(e) of U.S. Provisional Application No. 60/442,514, filed January 27, 2003.

FIELD OF THE INVENTION

This invention relates to fuel burner equipment and more particularly to a premixed fuel burner assembly.

BACKGROUND OF THE INVENTION

Premixed fuel burner assemblies are used with various heating equipment such as boilers, commercial hot water headers, fuel barbeques, and the like. Fuel burners are devices into which a flow of combustible fuel (usually gas) is introduced into a mixing chamber, where it is mixed with air supplied in a suitable proportion to the combustible gas. After mixing, the mixture of combustible fuel and air exits the mixing chamber through burner ports where it is ignited and burnt.

Specifically, a typical premixed fuel burner assembly consists of a hollow burner body having a closed end and an open end into which the premixed fuel/air flows. The burner body includes a porting area that consists of burner flame port perforations (i.e. slots and/or holes). Within the burner body is a venturi tube that typically contains a multiplicity of holes through and out which the fuel and air mixture from the interior of the body flows. Fuel and air are both provided into the boiler body through the venturi tube. Specifically, fuel is provided into the venturi tube through a fuel nozzle and air is provided around the fuel nozzle. Fuel and gas are mixed to produce a combustible mixture which subsequently is passed through the burner body and ignited to produce a burner flame that, in the case of a water heater, is applied to the a heat xchanger of the boiler.

Conventional premixed fuel burner assemblies produce short flames that are just beyond or above the burner porting area. Normally th mixture has 30 percent excess air so as to provide cleaner combustion products. At loadings (i.e. heat per unit area) below approximately 6 kilowatts per square decimeter, the burner port surface will be radiant since the velocity of the mixture is low resulting in the flame being positioned on or closely adjacent to the surface. This gives rise to problems of thermal fatigue and high temperature oxidation of the burner porting surface, and potential flashback of the flame into the burner body. At higher loadings (e.g. 12 kilowatts per square decimeter and above) the increase in volumetric flow is such that the velocity of the mixture may be increased to the point where the flame front is further from the burner porting surface resulting in a relatively cool porting surface. However, at high loadings if the amount of excess air is not or cannot be controlled, overheating of burner porting surface can still result when there is inadequate excess air (i.e. when there is too much fuel in the air/fuel mixture) since in such a case the flame will sit on the surface of the burner increasing the temperature. As is conventionally known, when the burner body becomes too hot (e.g. 2000 degrees Celcius) the fuel burner assembly can suffer failures, melting and irreversible damage.

Various types of fuel burner assemblies have been developed to attempt to maintain the flames above the surface of the outer cylinder by operating at high loadings (i.e. high fuel/air velocities) while at the same time maintaining a proper mix of fuel and flame stability. For example, U.S. Patent No. 6,461,152 to Wood et al. discloses a tubular burner consisting of a cylindrical tubular body into which a distributor component can be fitted. The distributor is substantially the same axial length as the tubular burner body but of a smaller cross-sectional dimension than said body so to allow for easy insertion. The distributor divides the burner body into an upper and a lower chamber. The distributor has a first tubular portion and a second extension portion each of which is provided with axially aligned flanges having a number of perforations. While this assembly achiev s a reasonable distribution of air and fuel streams prior to deliv ring the fuel/air mixture to the porting area of the tubular burner, the

construction and assembly of this burner is expensive, as is the manufacture of the various components involved in the construction.

SUMMARY OF THE INVENTION

The invention provides in one aspect, a premixed fuel burner assembly, comprising:

(a) a hollow tubular burner body having a longitudinal axis, said burner body having a longitudinal porting area having formed within a plurality of radially formed slots, said burner body having a first end and a second end;

(b) a hollow tubular venturi tube positioned within said burner body along said longitudinal axis extending from said first end;

(c) a distribution plate having a mid-section and longitudinal flanges, said flanges being coupled to the inside surface of burner body, said mid-section having a plurality of holes formed within, and said distribution plate being positioned within said burner body such that the holes of distribution plate are positioned adjacent to the radially formed slots within said burner body.

The invention provides in another aspect, a method of making a fuel burner assembly, said method comprising the steps:

(a) forming a tubular burner body;

(b) cutting a plurality of radial slots formed within said tubular body;

(c) forming a hollow tubular venturi tube and positioning it within aid burner body along said longitudinal axis extending from said first end;

(d) forming a distribution plate with a mid-section and longitudinal flanges;

(e) cutting a plurality of holes within the mid-section; and

(f) coupling the flanges of the distribution plate to the inside surface of burner body such that the distribution plate is positioned between the inside surface of the burner body and the venturi tube and such that the holes within the mid-section are positioned adjacent the slots of said burner body.

Further aspects and advantages of the invention will appear from the following description taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 is a side perspective view of the premixed fuel burner assembly of the present invention;

FIG. 2 is a side perspective view of the premixed fuel burner assembly of the present invention with internal components of the premixed fuel burner assembly being shown in dotted outline;

FIG. 3 is an radial cross-sectional view of the premixed fuel burner assembly of FIG. 2 taken along line B – B' of FIG. 2; and

FIG. 4 is a longitudinal cross-sectional view of the pre-mixed fuel burner assembly in use illustrating the position of flames in respect of the burner body.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1, 2 and 3, illustrated therein is a premixed fuel burner assembly **10** made in accordance with a preferred embodiment of the present invention. Fuel burner assembly **10** consists of a burner body **12**, a conventional fuel/air mixing venturi tube **14** (FIGS. 2 and 3), and a distribution plate **16**. Venturi tube **14** and distribution plate **16** are positioned within burner body **12** and together nsure good mixing of the fuel and air as the fu l/air

mixture is urged through burner body **12** and an even and raised flame profile on the porting area of burner body **12** to minimize thermal fatigue and oxidation effects on burner body **12**. Additionally, since fuel burner assembly **10** generates a high velocity of a well mixed fuel/air stream throughout the fuel burner assembly **10** such that excess air is evenly provided throughout the mixture, flame flashback and instability effects are inhibited.

Burner body **12** is a hollow cylindrical tube having preferably having a circular cross-section. However, it should be understood that burner body **12** could also have various shaped cross-sections (e.g. oval, rectangular, polygon, etc.) depending on the particular use of burner body **12**. For example, in the case where burner body **12** has an oval cross-section, the height of the combustion chamber can be minimized by orienting the minor axis in the vertical direction. Burner body **12** has a longitudinal axis A and is axially aligned with venturi tube **14** and distribution plate **16** as will be described. Burner body **12** is closed at one end **20** and open at the other end **22**. The closed end **20** and open end **22** are formed using conventionally known crimping techniques. The open end **22** is adapted to receive and mount one end of venturi tube **14** and distribution plate **16** as will be described The closed end of burner body **12** is closed so that burning is confined within burner body **12**. It should be understood that burner body **12** may be manufactured out of any high temperature resistant metal (e.g. stainless steel, aluminized steel, coated steel, etc.) Finally, burner body **12** should be understood to be any burner having an outer surface that defines an internal cavity in which venturi tube **14** and distribution plate **16** can be disposed.

As shown, the surface of burner body **12** includes a porting area **17** within which are formed a plurality of burner ports **18**. Burner ports **18** consist of a plurality of small radially oriented rectangular slots arranged in an offset manner as shown. Burner ports **18** keep the flame front **50** (FIG. 4) off of the surface of the deck while maintaining a stable flame which results in the surface of the burner body **12**,and in particular, the porting area **17** being maintained at a relatively low temperature. Burn r ports **18** are of an appropriate size for a particular application. For example, if fuel burner assembly is to be us d within a

hot water heater, burner ports **18** may be approximately 6 mm by 0.75 mm. Due to the equal configuration of burner ports **18** as well as the ev n distribution of mixed fuel/air above distribution plate **16** as will be discussed, an equal flame **50** height along the entire porting area **17** is provided (see FIG. 4).

Referring to FIGS. 2 and 3, venturi tube **14** is a hollow cylindrical tube having either a circular or oval cross-section. It should be understood that venturi tube **14** may be manufactured out of any high temperature resistant metal (e.g. stainless steel, aluminized steel, coated steel, etc.) Venturi tube **14** is axially aligned with the longitudinal axis of burner body **12** and positioned within burner body **12** along a short longitudinal section of burner body **12** from the open end **22** into the area within burner body **12**. The remainder of venturi tube **14** extends out of the open end **22** of burner body **12** and out of the combustion chamber and being attached to and spaced from a gas injection member (not shown) connected to a source of gas (e.g. natural gas outside of the water header).

The exterior surface of venturi tube **14** where it enters the combustion chamber is sealed using an end cap **42**. Flange 41 (FIGS. 1 and 2) is adapted to be fastened to an appliance in which fuel burner assembly **10** is used. End cap **42** is preferably formed using beeding and crimping methods to eliminate the necessity of welding, although welding can also be utilized. Accordingly, air is only provided through the venturi tube **14**. Preferably, three spacers (not shown) are used to maintain a centered longitudinal position for venturi tube **14**. A mixture of fuel and air is provided to venturi tube **14** through a fuel nozzle (not shown). The length and diameter of venturi tube **14** are selected to provide for proper mixing of fuel with air. Specifically, venturi tube **14** is sized so that more air than is required for combustion is provided (e.g. 30%) to reduce the maximum flame temperature and to provide cleaner combustion products (i.e. lower levels of toxic NO_x and carbon monoxide emissions). such that a high velocity of air/fuel mixture is provided to the area within burner body **12** underneath the porting ar a **17** of burner body **12**.

Referring to FIGS. 2 and 3, distribution plate **16** is a long plate having a C-shaped cross-section. Distribution plate **16** is adapted to axially aligned with the longitudinal axis of burner body **12** and to fit within minor section of burner body **12** directly underneath longitudinal porting area **17**. It should be understood that distribution plate **16** may be manufactured out of any high temperature resistant metal (e.g. stainless steel, aluminized steel, coated steel, etc.) Distribution plate **16** has two longitudinal folded flanges **24** and **26** and a mid-section **26**. A plurality of evenly spaced holes **28** is formed within the surface of mid-section **26**. Longitudinal folded flanges **24** and **26** (FIG. 3) are shaped to contact the inside surface of burner body **12** along its longitudinal length as shown.

The exterior surface of flanges **24** and **26** of distribution plate **16** are coupled to the inside surface of burner body **12** using an appropriate conventionally known welding technique (e.g. spot welding or seem welding techniques). Flanges **24** and **26** are coupled to the inside surface of burner body **12** such that that the mid-section **26** of distribution plate **16** is positioned underneath the longitudinal porting area **17** of burner body. Specifically, distribution plate **16** is positioned within burner body **12** such that the plane defined by the holes **28** within mid-section **26** of distribution plate is oriented along and collinear with the longitudinal axis of burner body **12** and such that holes **28** are positioned adjacent the burner ports **18** within porting area **17**.

Holes **28** on distribution plate **16** are of variable size. The size of each hole **28** varies according to its position on distribution plate **16**. Specifically, holes **28** are largest at one end of distribution plate **16** and smallest at the other end. The end at which holes **28** are the largest is intended to be located at the open end of fuel burner assembly **10** and the end at which holes **28** are smallest is intended to be located at the closed end **20** of fuel burner assembly **10**. Preferably, holes **28** are one of two sizes, where larger sized holes **30** clustered at the open end **22** and a small sized holes **32** which extend the length from the end of the cluster of the larger sized holes **31** until the closed end **20**. It should b understood that while only two sizes of holes ar shown and described, any form

of gradient of hole size is contemplated. Specifically, in between the ends of distribution plate **16**, holes **28** can be gradually reduced in size as they traverse from the open end **22** of fuel burner assembly **10** to the closed end of fuel burner assembly **10**. Further, various patterns or configurations of holes **28** are also contemplated depending on the particular functionality required by a particular application.

The holes **28** within distribution plate **16** allow for improved mixing of fuel and air between the distribution plate **16** and the inside surface of burner body **12** (i.e. "mixing chamber D" as shown in FIG. 4). The presence of larger holes at the closed end **20** and smaller holes at the open end **22**, provides for a higher degree of turbulence at the open end **22** of burner tube **12** and a lower degree of turbulence at the closed end **20**. Since fuel and air streams are being discharged at the open end **22**, increased amount of turbulence is needed at the open end **22** By directing an increased amount of turbulence to the open end **22** part of fuel burner assembly **10**, an improved efficiency in mixing of fuel and air streams can be achieved. In prior art fuel burner assemblies, turbulence is provided evenly at both open and closed ends of the burner assembly, resulting in unnecessary turbulence at the closed end and not enough turbulence at the open end for optimal fuel and air mixing. Accordingly, the specific arrangement of holes **28** within distribution plate **16** in conjunction with the shorted extent of venturi tube **14** together produce a substantially evenly distributed mixture of air and fuel within mixing chamber D and accordingly even and highly set flames **5** above porting area of burner body **12**. Further, this is provided without a high pressure drop.

FIG. 4 is a cross-sectional view of fuel burner assembly **10** illustrating how flames **50** sit above the porting surface **17** of burner body **12** at a distance represented by "C". This is the case due to the improved mixing capability of fuel burner assembly **10** and accordingly it's ability to maintain flame stability at high fuel/air mixtur⁻ velocities (i.e. high loading). Specifically, the volume d fined by between the top surface of distribution plate **16** and inside surface of burner body **16** constitutes a mixing chamb r D which receives a

mixed air/fuel stream through holes **28** in mid-section of distribution plate **16** and which redistributes the mix d air/fuel stream through burner ports **18** in burner body **12**. The mixing chamber constitutes a volume that is semi-circular in cross-section and which runs the entire length of burner body **12**. The holes **28** within (smaller holes **32** are shown in FIG. 4 since the closed end **20** section of fuel burner assembly **10** is shown) distribution plate **16** allow for improved mixing of fuel and air within the mixing chamber D. Further, by using larger holes at the closed end **20** and smaller holes at the open end **22**, increased turbulence is produced at the open end **22** of burner tube **12** as compared to the closed end **20**. Accordingly, flame flashback is prevented since distribution plate **16** physically prevents fuel from coming back to venturi tube **14**.

Accordingly, fuel burner assembly **10** is designed to maintain flames above the surface of burner body **12** by operating at high loadings (i.e. high fuel/air velocities) while at the same time maintaining a proper mix of fuel and flame stability. Fuel burner assembly **10** achieves these features through the use of a particularly perforated distribution plate **16** (i.e. variable sized holes **28**) as discussed in conjunction with a partially extending venturi tube to optimize the mixing process between fuel and air streams.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure described above are possible without departure from the present invention, the scope of which is defined in the appended claims.